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The Healthy Eating Index 2005 among 13-17 Year-Old Students in Iran

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ABSTRACT

Background: Quality of diet is one of the most important factors in maintaining and improving the children's health; whereas, the quality of children's diet has not been studied in Isfahan City of Iran. This study was conducted to assess the adequacy of diet using healthy eating index (HEI)-2005 among 13-17 year-old students in Isfahan during 2014. **Methods:** The empirical data on dietary intakes were collected after three-days of food record. Later, a valid and reliable standard questionnaire was administered to measure the participants' physical activities. The participants' dietary intakes, daily energy, and nutrients were recorded by four researchers and were analyzed using SPSS 22 by running ANOVA and Tukey tests. **Results:** The mean score of HEI in adolescents was 67.72. The correlation of calorie intake and mother's career with the HEI score was statistically significant ($P < 0.05$). **Conclusion:** Adults taking care of adolescents are recommended to improve the quality of diet among teenagers. They should also apply relevant methods to correct the adolescents' nutritional habits.

Keywords: Healthy eating index; Healthy diet; Adolescence; Daily diet modification; Nutritional status

Introduction

Inappropriate nutrition can contribute to the development of non-epidemic diseases. According to the literature, certain dietary patterns form 4, of 10, causes of death (i.e., cardiovascular disease, certain types of cancers, stroke, and type 2 diabetes). Healthy diets have been proved to reduce the risk factors of non-epidemic diseases such as obesity, hypertension, and hypercholesterolemia (Lake *et al.*, 2006). Several studies pointed out the effect of improper eating habits and inappropriate

food models in incidence of obesity and overweight mortality. Today, the prevalence of obesity and weight-related problems are frequently reported in adolescents (Hann *et al.*, 2001). Given that most nutritional habits get form during the adolescence period, inappropriate food habits continue to the adulthood (Lake *et al.*, 2006).

Unfortunately, a considerable number of adolescents follow diets that are not in line with nutritional recommendations; these nutritional

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habits can transmit to the adulthood, so that they would significantly influence the health condition of their future families and children (Katz, 2014). Adolescence is characterized by changing attitudes, personality development, independence, and social acceptance; so it is expected to have a potential impact on nutrition (Vaughn, 1996). Epidemiological studies over the relationship of diet with non-epidemic diseases have mostly addressed the role of taking just one nutrient in developing a disease. However, most foods contain numerous nutrients, so that taking a certain nutrient is associated with consumption of other nutrients. To address this challenge, some scholars have changed their attitude from the relationship between a nutrient and the risk of a disease towards the association of a dietary pattern with the risk of a disease development (Wirt and Collins, 2009).

Food guidelines are designed to improve the individuals' health status, reduce the risk of non-epidemic diseases, and to balance the food pyramid that directs people about food intake strategies. Among these strategies, the Healthy Eating Index (HEI), designed in 1995, was the first effort to assess the overall quality of any compliance diet through food guidelines and food pyramid (McCullough *et al.*, 2000). The recent HEI-2005, containing some modifications and improvements, was released to meet the increasing emphasis on diverse aspects of the diet quality such as whole grains, varieties of vegetables, specific types of fats, and introduction of the new concept of excess calories (Guenther *et al.*, 2013).

Torres *et al.* (Torres *et al.*, 2014) concentrated on the relationship between socio-environmental factors and the quality of a weight gain diet on 114 participants with 12 years of age. This study, carried out using a 24-hour recall, revealed that 75% of those with a normal weight compared to 57.5% of those with overweight or obesity were more likely to consume homemade foods. Most participants of this study had a normal weight, but suffered from a poor quality diet, so that 55% of the individuals with poor diet and 45% of the

remaining participants needed to change their diets.

Assumpção *et al.* (Assumpção *et al.*, 2012) carried out a research on Brazilian people (205 girls and 204 boys with 12-19 years old) using a 24-hour recall to measure the overall quality and adequacy of the diet components based on demographic, socio-economic, and body mass information data. In their study, the average HEI score for adolescents was reported as 59.7 (58.59 and 60.5 for girls and boys, respectively). In this regard, scores lower than 5 were obtained for fruits, milk, and dairy, while scores of higher than 8 were achieved for meat and eggs. The rest dietary patterns obtained a score between 5 and 8. The limitations of this research suggested a cross-sectional study and application of a self-reporting information questionnaire for measuring the participants' height and weight. Considering the above-mentioned issues, authors sought to determine the quality of diet based on the HEI -2005 among 13-14 years old students in Isfahan city in 2014.

Materials and Methods

Study design and participants: This cross-sectional descriptive-analytic study was conducted on 326 schoolchildren within the age range of 13-17 years in Isfahan selected by multi-stage (cluster) method. In this regard, the city regions were classified as levels, schools as clusters, and classes in each school as a class. The inclusion criteria were being in the age range of 13 to 17 years, having agreement to participate in the study, having no disease and intake of dietary supplements or certain drugs, and no following a particular diet. The exclusion criteria included being on a specific diet during implementation of the study. Moreover, participants or parents who lacked consent to participate in the study were removed. Children's parents were fully informed about the study objectives and methods. Adolescents and their parents were also required to sign an informed consent and fill the demographic information questionnaire (containing age, gender, education, medical and pharmaceutical history).

Measurements: A three-day dietary questionnaire record was applied to assess the dietary intake. The participants were asked to record all foods and drinks consumed by adolescents for 3 days (two working days and one weekend). To familiarize students with the correct recording method, video tutorials including the food album were utilized to exemplify sizes of the estimated food portions they consumed along with the meal recording sample. In order to ensure that the food is properly recorded, the information entered by students was checked in a registration sheet indicating whether the required information was fulfilled or not. Mothers were also supposed to help the researchers in the case that the adolescents filled the registration form task less accurately. Eventually, the gathered data from this questionnaire were analyzed by four nutritionists in terms of nutrition, dietary intake, and nutrient intakes.

The HEIs were classified into three categories of "good diet", "need satisfaction", and "poor diet". The HEI-2005 encompasses 12 items, including fruits, whole fruits, vegetables, dark green and orange vegetables as well as legumes, total grains, whole grains, milk (dairy and soy drinks), meat (poultry, fish, eggs, soy products, cereals and seeds), oils (non-hydrogenated vegetable oils, fish oil and nuts and seeds), saturated fat, sodium and calories from solid fats, alcoholic beverages, and added sugars. More consumption of the first nine above-mentioned nutrients increased the respondents' score, while lower intake of the latter three nutrients leads to a relatively higher score (Bowman *et al.*, 2008).

In order to determine the measurement units in the USDA's new pyramid, a regular glass was applied for groups of vegetables, fruits, and milk, while ounces (equivalent to 30 grams) were considered for grains and meat groups. Furthermore, the foods were categorized into food groups and the equivalent of each foodstuff group was obtained for each person (Bowman *et al.*, 2008). Given the energy level of each participant, the next step was calculating the amount of received energy in each group of food per 1000 kcal. The final scoring method was done as follow:

1. Fruits (whole fruit and juice): more than or equal to 0.8th equivalent glasses per 1000 kcal intake

= 5 points, not intake = zero points. Otherwise, the intake values were divided by 0.8 and then multiplied by 5 to calculate the fruit's score.

2. Whole Fruits: More than or equal to 0.4th equivalent glasses per 1000 kcal intake = 5 points, not intake = zero points. Otherwise, the intake amounts were divided by 0.4 and then multiplied by 5 to give total fruits score.

3. Grains (whole and refined grains): more than or equal to 3 equivalent of ounces per 1000 kcal = 5 points, not intake = zero points. Otherwise, the intake amounts were divided by 3 and then multiplied by 5 to calculate the grains score.

4. Whole grains: more than or equal to 1.5 equivalent of ounces per 1000 kcal intake = 5 points, not intake = zero points. Otherwise, the intake values were divided by 1.5 and then multiplied by 5 to calculate the total grains score.

5. Milk (i.e., all dairy products): more than or equal to 1.3 equivalents of glasses per 1000 kcal intake = 10 points, not intake = zero points. Otherwise, the intake values were divided by 1/3 and then multiplied by 10 to calculate the milk score.

6. Meat and beans: more than or equal to 2.5 equivalent of ounces per one thousand kcal intake = 10 points, not intake = zero points. Otherwise, the intake values were divided by 2.5 and then multiplied by 10 to calculate meat and beans scores. This section of the HEI -2005 includes four sub-categories: 1. Red meat, poultry and fish; 2. Eggs; 3. Peanuts and seeds; 4. Soybean products. Note that the subgroup of beans is located into the meat and beans category in addition to the fourth sub-groups.

7. Vegetables (all types of vegetables and legumes): more than or equal to 1/1 equivalents of glasses per 1000 kcal intake = 5 points, not intake = zero points. Otherwise, the intake values were divided by 1/1 and then multiplied by 5 to calculate the vegetables score.

8. Dark green and orange vegetables, and legumes: more than or equal to 0.4 equivalent of glasses per 1000 kcal intake = 5 points, not intake = zero points. Otherwise, the intake values were divided by 0.4 and then multiplied by 5 to score these points.

9- Vegetable oils: More than or equal to 12 grams per 1000 kcal intake = 10 points, not intake = zero points, otherwise the intake quantities were divided by 12, and then multiplied by 10, to calculate the oils score.

10. Saturated fat: Less than or equal to 7% of the intake energy = 10 points, more than or equal to 15% of the intake energy = zero points, 10% of the intake energy = 8 points. If the percentage of intake values was greater than 10 and less than 15 percent, it was calculated by the following equation: = $(5/(10 - \text{saturated fat}) * 8) - 8$, and if the percentage was greater than 7 and less than 10%, it was calculated using this equation: = $(3.7 - \text{intake saturated fat}) * 2 - 10$.

11. Sodium: To calculate the sodium within diet, the amounts of sodium in the diet (by four nutritionists) and sodium table were evaluated in this way: Less than or equal to 0.7 grams per 1000 kilocalories = 10 points, greater than or equal to 2 grams per 1,000 kilocalories = zero points and equal to 1.1 grams per 1,000 kcal = 8 points. If the intake was more than 0.7 and less than 1.1, then the sodium score = $(0.4 / (0.7 - \text{intake sodium}) * 2) - 10$, and if the intake was more than 1.1 and less than 2, the sodium score = $(0.9) / (1.1 - \text{intake sodium}) * 8 - 10$.

12. Intake calories of solid fat, alcoholic beverages, and added sugar (SoFAAS): Less than or equal to 20 percent of calories intake = 20 points, more than or equal to 50% of the intake calories = zero; otherwise, the values will be calculated from this equation, Calorie Score of SoFAAS = $(30 / (20\% \text{ Calories of SoFAAS}) * 20) - 20$.

Measuring the participants' weight, height, and abdominal variables were performed by a trained person to ensure more accuracy. The standard and

validity of the questionnaire were confirmed by Faghihimani et al. (Faghihimani *et al.*, 2010) in a study that was basically designed for the 14-19 year-old group to measure adolescents physical activities (A-PAQ)(Tardivo *et al.*, 2010).

Data analysis: The data were recorded, tabled as descriptive statistics, and finally analyzed by SPSS software through ANOVA and Tuckey tests at a significant level of 0.05.

Results

Table 1 illustrates the demographic and anthropometric characteristic of the students. The total average score of HEI was 67.72; for boys and girls, the HEI was 72.84 and 72.52, respectively. Based on the results, none of the variables such as age, weight, abdominal circumference, body mass index (BMI), and calorie intake in HEI categories differed significantly ($P < 0.05$). The relevant percentage of people in different category of HEI is given in **Table 2**. According to the findings, mother's job and participants' calorie intake had a statistically significant relationship with HEI (**Table 3**).

Table 4 provides the dietary intake of participants according to different categories of HEI. Their consumption amounts of whole fruits, whole vegetable, dark green and orange vegetables, and legumes, whole grains, and meat in "good diet" category were significantly higher than those of "need satisfaction" and "poor diet" categories ($P = 0.01$). Sodium and saturated fatty acids were significantly lower in "good diet" category compared to other categories ($P = 0.01$). However, no correlation was found between intake of total grain, dairy, oils, and SoFAAS with HEI category.

Table 1. Demographic and anthropometric characteristics of participants

Variables	Poor diet (n=107)	Need imrovment (n=109)	Good diet (n=110)	P-value ^b
Age (year)	14.44 ± 1.55 ^a	14.47 ± 1.48	14.70 ± 1.56	0.40
Weight (kg)	57.01 ± 14.50	55.16 ± 11.44	57.17 ± 12.94	0.50
Abdominal circumference (cm)	75.59 ± 10.12	74.37 ± 8.33	75.90 ± 8.92	0.74
Body mass index (kg/m ²)	21.44 ± 4.67	20.68 ± 3.40	24.46 ± 3.88	0.42
Energy intake (kcal)	2185.51 ± 643.92	2173.10 ± 659.44	2191.27 ± 703.45	0.95

^a : Mean ± SD; b: ANOVA test

Table 2. Descriptive indicators of adolescents in different groups of HEI

Variables	levels	Poor diet N(%)	Need imrovment N(%)	Good diet N(%)	Total N(%)
Father's education	Illiteracy	3(25.0)	6(50.0)	3(25.0)	12(4.0)
	Elementary, Cycle	30(33.3)	31(34.4)	29(32.2)	90(27.6)
	Diploma	45(36.0)	43(34.0)	38(30.0)	126(38.5)
	Bachelor, Master	32(33.3)	30(31.2)	34(35.4)	96(29.3)
	P.H.D	-	1(50.0)	1(50.0)	2(0.6)
Mother's education	Illiteracy	8(40.0)	5(25.0)	7(35.0)	20(6.1)
	Elementary, Cycle	30(31.0)	38(38.0)	30(31.0)	99(30.4)
	Diploma	45(34.0)	42(32.0)	47(34.0)	131(40.2)
	Bachelor, Master	29(39.1)	25(33.8)	20(27.0)	74(22.7)
Father's job	Freelancer	49(35.3)	48(34.5)	42(30.1)	139(42.6)
	Employee	31(30.0)	36(35.0)	36(35.0)	103(31.6)
	Retired	14(32.0)	14(32.0)	16(36.0)	44(13.4)
	Others	17(42.5)	10(25.0)	13(32.5)	40(12.4)
Mother's job	Housewife	83(33.0)	80(32.2)	86(34.7)	249(76.3)
	Employee	14(33.3)	18(42.8)	10(23.8)	42(12.9)
	Retired	1(14.3)	3(43.0)	3(43.0)	7(2.1)
	Freelancer	13(46.4)	7(25.0)	8(28.6)	28(8.6)

Table 3. Logistic regression test results in related factors of HEI

Variables	Regression coefficient	SE	Standardized regression coefficient	P-value	
Age (year)	-0.07	2.31	0.05	0.97	
Sex	-0.29	1.01	-0.02	0.77	
Abdominal circumference (cm)	0.63	3.85	0.01	0.87	
Weight status	Obesity	-	-	-	
	Normal	-0.43	3.06	-0.02	0.90
	Overweight	-1.79	3.06	-0.09	0.71
Energy intake (kcal)	high	-	-	-	
	low	-4	1.10	-0.23	<0.001
	moderate	-1.37	1.21	-0.08	0.27
Father's education	P.H.D	-	-	-	
	illiteracy	-3.23	3.79	-0.07	0.39
	Elementary, cycle	-3	2.14	-0.16	0.16
	Diploma	-2.26	1.92	-0.13	0.24
	Bachelor,MA	-0.40	1.99	-0.02	0.84
Mother's education	Bachelor,MA	-	-	-	
	Illiteracy	2.34	3.10	0.07	0.45
	Elementary, cycle	2.80	1.79	0.16	0.12
	Diploma	1.86	1.03	0.11	0.22
Father's job	Others	-	-	-	
	Free	2.48	1.02	0.10	0.10
	Employee	2.02	1.79	0.14	0.14
	Retired	3.19	1.92	0.13	0.09
Mother's job	Others	-	-	-	
	housewife	6.06	2.27	0.34	<0.004
	Free	0.86	3.15	0.14	0.06
	Employee	0.01	2.69	0.22	<0.04
	Retired	8.93	3.92	0.16	<0.02

Table 4. The results of ANOVA test (mean±SD) were used to compare the components of healthy nutrition index

Variables (g)	Poor diet n=107	Need improvement n=109	Good diet n=110	P-value
Total fruits	95.09±84.83	152.58±104.39	172.56±93.88	<.001
Whole fruits	75.83±78.46	129.99±86.54	153.96±91.59	<.001
Total vegetables	110.56±56.58	103.27±69.85	146.32±96.28	<.001
Dark green and orange vegetables, and legumes	36.19±44.10	45.88±44.39	82.06±67.07	<.001
Total grains	245.86±102.14	264.02±121.88	271.30±120.99	.36
Whole grains	10.38±27.27	13.96±24.59	24.77±32.22	<.001
Dairy	218.20±131.11	218.53±132.82	256.49±139.78	0.02
Meat	67.80±32.42	80.79±29.61	85.71±40.76	<.001
Oil	17.22±8.39	17.58±7.37	16.56±6.94	.36
SoFAAS ^a	21.97±10.30	20.18±5.16	20.53±4.35	.76
Sodium	2.13±.00	1.79±0.99	1.30±0.04	<.001
Saturated fat	10.96±13.45	8.39±0.08	7.74±0.03	<.001

^a: intake calories of Solid Fat, Alcoholic beverages and Add Sugar

Discussion

The results of this study made a contribution in quantifying the average HEI of the target group (72.67) and suggested the participants' diet modification. However, our findings contradict with some results from previous studies. For instance, the results reported by Azizi et al. (Mirmiran *et al.*, 2004) on 10-18 years old students in Tehran indicated a lower average for HEI. A research on students aged 14-18 years old in Ankara by Acar Tek et al. (Acar Tek *et al.*, 2011) showed a considerably lower average of HEI, which may be a result of their higher consumption of dairy, meat, and oil in comparison to the current study.

Based on our findings, HEI in boys and girls did not have a significant difference, which was confirmed by Acar Tek et al. (Acar Tek *et al.*, 2011). Azizi et al. (Mirmiran *et al.*, 2004) found that the HEI for girls aged 10-14 was higher than boys of the same age, but in the 15-18 age range, This ratio was the opposite.

Similar to Azizi et al. (Mirmiran *et al.*, 2004), we found no relationship between the participants' age and HEI; however, in the study by Acar Tek et al., a correlation was observed between the adolescents' age and their HEI (Acar Tek *et al.*, 2011).

The participants' BMI and abdominal circumferences were not significantly associated

with the HEI based on the results of several studies (Asghari and Mirmiran, 2010, Ervin, 2008, Tande *et al.*, 2010), although the rest of studies reported that HEI had a reverse association with BMI and abdominal circumference (Aliabadi *et al.*, 2007, Azadbakht *et al.*, 2005, Gao *et al.*, 2008). Based on some review studies, the causes of these conflicting relationships would be the age of participants, study methods, food research methods, different food patterns in different regions, type and structure of food indices, lack of a gold standard for using these indices in different regions, genetic predisposition to obesity, and the uncontrolled interventional variables (Togo *et al.*, 2001).

In this study, the level of calorie intake was significantly correlated with the HEI, so that in higher scored items within the HEI, the calorie intake was relatively lower, which is consistent with other studies (Acar Tek *et al.*, 2011, Hurley *et al.*, 2008). On the other hand, the positive or negative correlation between energy intake and the HEI score could be related to the methods of assessing quality of the diet- the original HEI or HEI 2005- due to their varied components.

The study by Acar Tek et al. (Acar Tek *et al.*, 2011), found no positive and significant correlation between parent education and HEI. Additionally,

AssumpçãoI et al. (Assumpção *et al.*, 2012) studied 409 adolescents aged 12-19 years in Sao Paulo and implied that the quality of a diet enhanced based on the level of the household head education (from diploma to academic degrees). This is believed to be a result of the prevailing social conditions among adolescence for food options without getting help from parents.

In contrast to father's job, a positive and significant relationship was observed between mother's career and HEI, which can be explained by the high levels of nutritional information and higher contribution in family income by mothers active in the community.

In the present study, the mean score of whole fruits, vegetables, dark green and orange vegetables, as well as legumes' intake was lower than some other studies (Aghanuri *et al.*, 2012, Perkins, 2010). Although the WHO recommends at least 400 grams per day of fruits and vegetables (3), our finding gained a lower amount of fruits and vegetables in adolescents compared to this level. Iran is a rich country in affording fruits and vegetables, but consumption of these foods is extremely lesser than the international recommended level. Perhaps this is the reason of high consumption of fast foods containing high amounts of carbohydrates and lipids by adolescents. Although the mean score of dairy intake was quite high in the research by Acar et al. (Acar Tek *et al.*, 2011), it was smaller than other published studies (Aghanuri *et al.*, 2012, Perkins, 2010).

In this regard, the participants' age, caring and benefiting from enough training regarding dairy consumption, and role of dairy products in building bone density and decreasing the risk of osteoporosis are of great importance (Fisberg *et al.*, 2006).

The average score of oil intake was higher than most studies (Acar Tek *et al.*, 2011, Aghanuri *et al.*, 2012, Perkins, 2010). Moreover, the average score of whole grains' consumption was lower in some studies (Perkins, 2010) and higher in others (Acar Tek *et al.*, 2011, Aghanuri *et al.*, 2012). Taste, texture, appearance, and availability were among the factors that could affect the total grain

consumption. Consumption of total grains on the basis of recommended levels protects us from chronic diseases and contributes to keeping the weight. Increased consumption of whole grains, improves the diet quality in the HEI -2005 (O'Neil *et al.*, 2011). However, in general, consumption of whole grains is low among children and adolescents (Harnack *et al.*, 2003, Larson *et al.*, 2010).

The average intake of sodium and saturated fatty acids was high in some studies (Acar Tek *et al.*, 2011, Perkins, 2010) and less in one study (Aghanuri *et al.*, 2012) among adolescents. Our participants' levels of meat and bean consumption were higher than other studies (Acar Tek *et al.*, 2011, Aghanuri *et al.*, 2012, Perkins, 2010), which could be due to the participants' age as an essential factor in the growth stages. However, enough attention was not paid to add up vegetables into diets. The SoFAAS score in this study was higher than some studies (Aghanuri *et al.*, 2012, Perkins, 2010), but lesser than another (Acar Tek *et al.*, 2011). In general, it should be taken into account that students' daily diet needs to be modified to compensate for the low levels of vegetables, dark green and orange vegetables, legumes, whole grains, dairy products, and high salt intakes.

Limitations of this study were its cross-sectional design and adolescents' lack of attention to fill out the food record accurately. Future researchers are suggested to apply a higher statistical society.

The present study was the first study conducted in Iran that examined the quality of diet using the HEI-2005 among students aged 13-17 years through a three-day FFQ to evaluate the dietary intake.

By assessing the diet's adequacy through HEI-2005, this study concluded that most participants were required to modify their diet quality. Therefore, in order to improve the quality of their diet, adolescents' nutritional habits should be corrected by taking measures such as educational programs and public advertisements. Schools are the most suitable places for educating families

about the risk of developing chronic illnesses through their diet.

Authors' contributions

Nourian M, Azadbakht L designed and developed this study. Mahaki B analyzed the data. Yaghubloo KH conducted the study, wrote the manuscript, and participated in the data collection. All authors read and approved the final manuscript.

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Authors' contributins

Nourian M, Azadbakht L designed and developed this article. Mahaki B analyzing the data. Yaghubloo KH conducted, wrote the manuscript and participated in the data collection. All authors read and approved the final manuscript.

Conflict of interest

There is no conflict of interest.

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